

## CLAIMS

What is claimed is:

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1. A gas treatment plant comprising:

5 a first absorber in which a lean solvent absorbs carbon dioxide, hydrogen sulfide, and a hydrocarbon;

a second absorber fluidly coupled to the first absorber, wherein at least part of the hydrogen sulfide is separated from the carbon dioxide; and

10 a sulfur plant that receives the at least part of the hydrogen sulfide to produce a sulfur product and a tail gas, wherein at least part of the tail gas is hydrogenated and is recycled to the absorber.

2. The gas treatment plant of claim 1 further comprising a regenerator that is fluidly coupled to the first and second absorber, wherein the regenerator produces an acid gas, and wherein at least part of the hydrocarbon is separated from the acid gas as a hydrocarbon liquid.

15 3. The gas treatment plant of claim 2 further comprising a third absorber that receives at least part of the hydrocarbon liquid and in which residual sulfurous compounds are at least partially removed from the hydrocarbon liquid.

4. The gas treatment plant of claim 3 wherein the residual sulfurous compounds are fed to a sulfur plant.

20 5. The gas treatment plant of claim 1 wherein the second absorber is operated at a lower pressure and at a higher temperature than the first absorber such that that the carbon dioxide desorbed from the solvent in the second absorber has a purity of at least 90 mol%.

25 6. The gas treatment plant of claim 5 wherein the carbon dioxide is used for enhanced oil recovery or used as commercial product.

7. A gas treatment plant comprising:

an absorber that receives (a) a feed gas comprising carbon dioxide and hydrogen sulfide, (b) a carbon dioxide saturated lean solvent, and (c) that produces an overhead vapor comprising at least a portion of the carbon dioxide; and

wherein a lean solvent is combined with the overhead vapor and cooled to form the carbon dioxide saturated lean solvent, thereby increasing selective absorption of the hydrogen sulfide from the feed gas in the lean solvent.

8. The gas treatment plant of claim 7 wherein the absorber produces a bottom product that is reduced in pressure and heated to a temperature sufficient to desorb the carbon dioxide from the bottom product.

9. The gas treatment plant of claim 8 wherein at least a portion of the hydrogen sulfide in the desorbed carbon dioxide is absorbed in a second absorber using a portion of the carbon dioxide saturated lean solvent.

10. A gas treatment plant comprising:

a solvent regenerator that receives from a plurality of absorbers a solvent comprising an acid gas and a hydrocarbon, and that produces an overhead vapor;

a separator that receives the overhead vapor and separates the acid gas from the hydrocarbon to form a hydrocarbon liquid; and

a stripper that fractionates the hydrocarbon liquid to produce a hydrogen sulfide depleted hydrocarbon product and a vapor comprising hydrogen sulfide that is fed to a sulfur plant.

11. The gas treatment plant of claim 10 wherein the acid gas is fed to an absorber in which a carbon dioxide depleted hydrogen sulfide rich solvent scrubs the acid gas.

12. The gas treatment plant of claim 11 wherein the scrubbed acid gas is fed to the sulfur plant.

13. The gas treatment plant of claim 12 wherein the sulfur plant produces a tail gas, and wherein at least part of the tail gas is hydrogenated and is recycled to at least one of the plurality of the absorbers.
14. A gas treatment plant comprising:
- 5 an absorber that receives from a solvent regenerator a vapor comprising hydrogen sulfide and a hydrocarbon, and that further receives a carbon dioxide-depleted solvent comprising hydrogen sulfide; and
- wherein the absorber produces a hydrocarbon-depleted overhead vapor comprising hydrogen sulfide that is fed to a sulfur plant, and a hydrocarbon-enriched
- 10 bottom product that is recycled to the solvent regenerator.
15. The gas treatment plant of claim 14 wherein the carbon dioxide-depleted solvent is produced by another absorber that separates hydrogen sulfide from carbon dioxide using a carbon dioxide saturated lean solvent.
16. The gas treatment plant of claim 14 wherein a portion of the carbon dioxide-depleted
- 15 solvent is fed to the solvent regenerator.
17. A method of treating a gas comprising:
- optionally contacting the gas with a first portion of a lean solvent to absorb at least one of a heavy hydrocarbon and a heavy mercaptan from the gas into the first portion of the lean solvent;
- 20 cooling the gas and contacting the cooled gas in an absorber with a second portion of the lean solvent to absorb at least one of a light hydrocarbon, a light mercaptan, and  $H_2S$  into the second portion of the lean solvent, wherein the second portion of the lean solvent is saturated with carbon dioxide;
- contacting the gas exiting the absorber with a third portion of the lean solvent to
- 25 saturate the third portion with carbon dioxide thereby forming a gas solvent mix; and
- cooling and separating the gas solvent mix, thereby forming the second portion of the lean solvent that is saturated with carbon dioxide.

18. The method of claim 17 wherein the step of optionally contacting is performed before the gas enters the absorber, and wherein the contacted gas is cooled before the contacted gas enters the absorber.
- 5 19. The method of claim 17 wherein part of the second portion of the lean solvent that is saturated with carbon dioxide is employed in another absorber as an absorbing solvent that removes hydrogen sulfide from a vapor.
20. The method of claim 19 wherein the another absorber is operated under conditions to reject carbon dioxide from the part of the second portion of the lean solvent.